



US005639373A

United States Patent [19][11] **Patent Number:** **5,639,373****Mahendran et al.**[45] **Date of Patent:** **Jun. 17, 1997**

[54] **VERTICAL SKEIN OF HOLLOW FIBER MEMBRANES AND METHOD OF MAINTAINING CLEAN FIBER SURFACES WHILE FILTERING A SUBSTRATE TO WITHDRAW A PERMEATE**

Primary Examiner—Frank Spear
Attorney, Agent, or Firm—Alfred D. Lobo

[57] **ABSTRACT**

A vertical skein of "fibers", opposed terminal portions of which are held in headers unconfined in a modular shell, is aerated with a gas-distribution means which produces a mass of bubbles serving the function of a scrub-brush for the outer surfaces of the fibers. The membrane device is surprisingly effective with relatively little cleansing gas, the specific flux through the membranes reaching an essentially constant relatively high value because the vertical deployment of fibers allows bubbles to rise upwards along the outer surfaces of the fibers. Further, bubbles flowing along the outer surfaces of the fibers make the fibers surprisingly resistant to being fouled by build-up of deposits of inanimate particles or microorganisms in the substrate provided that the length of each fiber is only slightly greater than the direct center-to-center distance between opposed faces of the headers, preferably in the range from at least 0.1% to about 5% greater. For use in a large reservoir, a bank of skeins is used with a gas distributor means and each skein has fibers preferably >0.5 meter long, which together provide a surface area >10 m². The terminal end portions of fibers in each header are kept free from fiber-to-fiber contact with a novel method of potting fibers.

[75] **Inventors:** Mailvaganam Mahendran, Hamilton;
 Carlos Fernando F. Rodrigues,
 Brampton; Steven Kristian Pedersen,
 Burlington, all of Canada

[73] **Assignee:** Zenon Environmental Inc., Burlington,
 Canada

[21] **Appl. No.:** 514,119

[22] **Filed:** Aug. 11, 1995

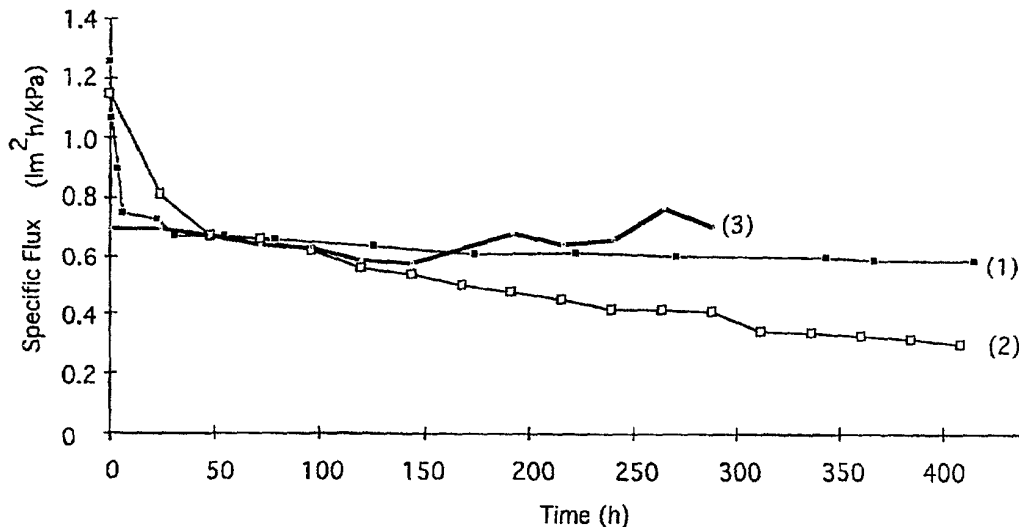
[51] **Int. Cl.**⁶ B01D 65/02

[52] **U.S. Cl.** 210/636; 210/34.69; 210/356;
 210/500.23

[58] **Field of Search** 210/355, 356,
 210/321.85, 410, 500.23, 321.8, 636, 321.69;
 264/258

[56] **References Cited****U.S. PATENT DOCUMENTS**

3,708,071 1/1973 Crowley 210/500.23 X
 4,647,377 3/1987 Miura 210/356 X
 5,248,424 9/1993 Cote et al. 210/321.8 X

22 Claims, 12 Drawing Sheets

TOTTOT 02254660